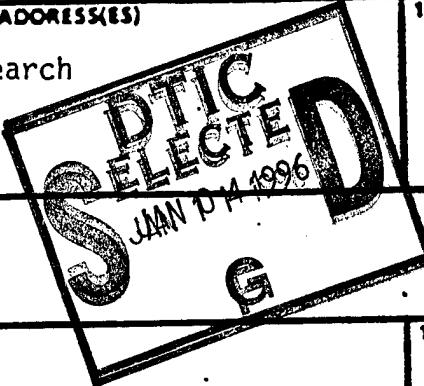


# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

Any reporting burden of this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Resources, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project 0704-0188, Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	March 1, 1995	Final Tech. Sept. 1993 - Sept. 1994
4. TITLE AND SUBTITLE		5. FUNDING NUMBERS
Enhancement of Digital Data Acquisition and Processing System of IIT/FDRC		F49620-93-1-0613
6. AUTHOR(S)		
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)		
Mechanical and Aerospace Engineering Department Illinois Institute of Technology Chicago, IL 60616		
8. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		
Air Force Office of Scientific Research Bolling Air Force Base, DC 20332		
9. SPONSORING/MONITORING AGENCY REPORT NUMBER		
C792		
10. DISTRIBUTION/AVAILABILITY STATEMENT		
 Approved for public release Distribution Unlimited		
11. DISTRIBUTION CODE		
12. ABSTRACT (Maximum 200 words)		
Computers and data acquisition equipment were purchased to enhance the data processing capabilities at the IIT/Fluid Dynamics Research Center (FDRC). The equipment upgraded the center from Masscomp-based systems to Silicon Graphics/CAMAC Crate Modular System. This gives the FDRC substantially more computer processing power, and flexibility to reconfigure the data acquisition systems to fit each particular experiment. The AFOSR grant was used to purchase a central server computer, 5 peripheral workstations, 4 portable data acquisition crates and an auxiliary disk. The equipment purchased has a direct impact on seven ongoing research projects sponsored by AFOSR, ONR, NASA, and NSF.		
13. SUBJECT TERMS		
Computer, data acquisition systems		
14. SECURITY CLASSIFICATION OF REPORT		
15. NUMBER OF PAGES 8		
16. PRICE CODE		
17. SECURITY CLASSIFICATION OF THIS PAGE		
18. SECURITY CLASSIFICATION OF ABSTRACT		
19. LIMITATION OF ABSTRACT		

DATA QUALITY INSPECTED &

19960103 041

# ENHANCEMENT OF DIGITAL DATA ACQUISITION AND PROCESSING SYSTEM OF IIT/FDRC

## FINAL REPORT

(September 1993 - September 1994)

Prepared by:

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Accession Per	
NTIS Classification	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution / _____	
Availability Codes	
Dist	Avail and / or Special
A-1	

For

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Grant No. F49620-93-1-0613

AFOSR Project Manager

Dr. Jim McMichael

March 1, 1995

## FINAL REPORT

Enhancement of Digital Data Acquisition and Processing System of IIT/FDRC

by

David R. Williams

March 1, 1995

AFOSR GRANT - F49620-93-1-0613

### **I. Summary of Equipment Purchases**

The computer and data acquisition systems purchased through the AFOSR Grant has had a major impact on data processing at the Fluid Dynamics Research Center (FDRC) and at Illinois Institute of Technology. The equipment has allowed us to perform state-of-the-art data analysis on a variety of different research projects supported by AFOSR and other agencies within the Department of Defense and NASA.

In particular, the use of PV-Wave software for processing and visualizing large data sets has strongly influenced our approach to data analysis. The software is accessible to all of the FDRC laboratories through the network server. Researchers can rapidly develop processing algorithms, which allows different approaches to be explored. For example, the development of a new spatial decomposition algorithm was done with PV-Wave which led to the first quantitative measurements of three-dimensional waves in the wake of a cylinder.

Furthermore, the purchase of this equipment has acted as a catalyst on the IIT campus, to change virtually all of the university computing environment to Silicon Graphics machines. With the strong background in Scientific data processing at FDRC, the university agreed to establish a Research Data Visualization Center under the direction of the FDRC. This center is currently under construction at IIT

The actual purchases under the AFOSR Grant exceeded our expectations described in the proposal. Table I provides a comparison of the equipment proposed to that actually

purchased. Between the time the proposal was submitted and the date of the award, Silicon Graphics introduced a less expensive version of the Indy workstation with performance comparable to the equipment we proposed to buy. As a result, we were able to buy five workstations instead of three with a net savings of about \$3,000. The additional money was used to purchase an auxiliary disk and service contract for the computers.

Closer consideration of the options available for the CAMAC data acquisition crates enabled us to purchase four crates instead of the three proposed for an additional \$4,000. However, this meant we could not purchase the two printers under this grant.

The C- Compiler for the Challenge L Server was obtained without charge.

**Table I      Equipment Purchases**

Item	Quan	Proposed Item	Proposed Cost	Actual Item Purchased	Actual Cost
1	1	SGI Challenge L Server (100 MHz)	\$52,975	same (150 Mhz) <sup>1</sup>	\$53,302
2	3	SGI Indigo Workstations	\$34,445	(5)Indy workstations <sup>2</sup>	\$31,856
3	3	Kinetic Systems Data Acquisition Systems + Aux. Crate Controller	\$61,605	(4) were purchased	\$65,677
4	2	Printers	\$5,000	not purchased <sup>3</sup>	
5	1	C-compiler	\$1,914	not-purchased <sup>4</sup>	
6				Aux. disk drive <sup>5</sup>	\$1,005
7				SGI Warranty <sup>6</sup>	\$4,099
		Total	\$155,939		\$155,939

Notes:

1) A faster version of the same Challenge L server was purchased at a slightly higher cost.

- 2) Between the time of the proposal and the awarding of the grant, SGI offered a new computer, the Indy workstation to replace the Indigo. For less cost we could buy 5 machines instead of the 3 which we proposed.
- 3) Printers were not purchased by this grant.
- 4) The C- compiler was obtained at no cost, therefore, we did not purchase a compiler from SGI as originally planned.
- 5) An auxiliary disk was purchased (in part) by the funds remaining in the grant.
- 6) A warranty package was purchased from SGI that allowed us to obtain a CD-ROM drive at a reduced price.

## **II. Projects Impacted by Computers and Data Acquisition Systems**

A brief description of the impact of the computers and data acquisition systems on existing research projects is described below.

Title of Project:      Closed-Loop control Systems for Unsteady Forebodies and Three-Dimensional Pitching Airfoils at High Reynolds Numbers

Sponsor:                AFOSR

Project Summary: The goals of this research program are to develop feedback control systems capable of enhancing the maneuverability of aircraft at high angles of attack. The project combines expertise in the areas of control theory and fluid mechanics to explore different control approaches on geometric bodies common to most aircraft. The goal of the control system is to modify the vorticity field with very low power actuators, so that a desired flow state is maintained through complex maneuvers at high angles of attack. The three main topics covered by the research are:  
1) vortex control on forebody modes at high Reynolds number and unsteady flow conditions,

- 2) vorticity field control on three-dimensional swept wings at high angles of attack,
- 3) and development of suitable control law algorithms for rapid control of the flow fields described in (1) and (2).

**Title of Project:** Investigation of the Physics of Screech in Supersonic Jets and Turbulent Boundary Layers at High Reynolds Numbers.

**Sponsor:** AFOSR

**Project Summary:** A three component research program aimed at the development of an enhanced physical understanding of the screech phenomena in supersonic jets and of the wall-layer dynamics in high Reynolds number turbulent boundary layers. Our aim is to utilize the recently developed technology of micro-sensors and the unique capabilities of the National Diagnostic Facility (NDF) to develop predictive and control capabilities for I) screech in high-speed jets and ii) high Reynolds number boundary layers.

**Title of project:** "Development of an accurate measurement technique for turbulent wall-pressure"

**Sponsor:** ONR

**Project Summary:** This is a research effort which is aimed at developing an accurate and reliable technique for measuring the turbulent wall pressure fluctuations under a canonical turbulent boundary layer. In particular, we are focused on developing solutions to two common problems in wall-pressure measurements: 1) probe resolution effects and 2) contamination of the low-frequency information by wind-tunnel noise. Reynolds number effects on the measurements is also being investigated.

Title of Project: Wall-Pressure Signatures and Instantaneous Flow Structure in High Reynolds Number Turbulent Boundary Layers.

Sponsor: ONR

Project Summary: To investigate the relative role of the separate scales of motion in a turbulent boundary layer on the wall-pressure signature over a wide range of Reynolds numbers. Using Particle Image Velocimetry the *instantaneous* velocity and vorticity patterns can be investigated and related to the simultaneously acquired wall-pressure fluctuations beneath the turbulent boundary layer.

Title of Project: Presidential Young Investigator Award

Sponsor: NSF

Project Summary: To establish and expand the Particle Image Velocimetry (PIV) capabilities at IIT. A PIV data acquisition system consisting of two Nd:Yag lasers was purchased and an interrogation system was built using NSF funding. This system is being used in a PIV investigation of turbulent boundary layers. The PIV capabilities have been expanded to Digital PIV with additional funding secured from DURIP and NSF based upon the results of the NSF-PYI award.

Title of Project: NASA National Space Grant College and Fellowship Program

Sponsor: NASA

Project Summary: To provide support for exceptional students working in the IIT/FDRC. Students currently supported under the NASA Space Grant program are investigating high Reynolds number turbulent boundary layers and wall-pressure signatures of turbulent boundary layers.

Title of Project: PIV Investigation of Turbulent Boundary Layers Subjected to Internally or Externally Imposed Time-Dependent Transverse Shear.

Sponsor: ONR

Project Summary: The proposed experiments are aimed at providing clean and controllable "canonical" non-equilibrium flows that can be conveniently incorporated into computational schemes ranging from direct numerical simulation to large eddy simulation and eddy viscosity modeling. Distinct contributions of the research to the ONR-ARI effort will include: advancement of the PIV technique to new capabilities leading to determination of all three components of the velocity in a plane with a significant mean velocity normal to it; investigation of the effect of an internally imposed transverse shear (steady and time dependent) on a turbulent boundary layer; and investigation of the effect of an externally imposed transverse shear (steady and time dependent) on a turbulent boundary layer